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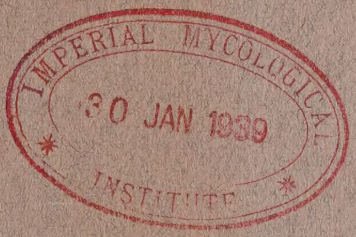

Breeding Winter Wheat for Resistance to Stinking Smut

(Tilletia levis and *Tilletia tritici)*

T. A. KIESSELBACH AND ARTHUR ANDERSON
Department of Agronomy

Lincoln, Nebraska
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SUMMARY

Several productive lines of hard red winter wheat which are highly resistant to both species of stinking smut (*T. levis* and *T. tritici*) have been isolated from the Turkey variety. Artificial-smut and stem-rust epidemics and controlled freezing have been found useful supplements to field-performance tests.

In response to inoculation in the seedling stage with four physiologic forms of black stem rust (*Puccinia graminis tritici*), all of these Turkey selections gave indications of superior rust resistance. When subjected to low temperatures, three of them appeared to be as cold-resistant as Nebraska No. 60, a standard and extensively grown wheat in Nebraska.

These same three selections, in duplicate field plats in 1930, ranged from 4.3 to 4.8 bushels higher in yield per acre than Nebraska No. 60, and ripened from one to three days earlier. In the nursery the average yield from ten replications ranged from 1.9 bushels less to .9 bushel per acre more than the parent variety.

Some segregates of hybrids between standard susceptible and resistant varieties have given such favorable reactions to inoculation with various collections of smut that this method of obtaining new resistant lines seems to give much promise.

All collections of smut from Nebraska and other central states of the hard red winter wheat belt proved to be *T. levis*. Four other collections used in these tests were *T. tritici*.

Differential reactions of the new Turkey selections and a number of hybrid selections and established resistant varieties to collections of bunt from a number of states give definite evidence of the occurrence of mild and virulent physiologic forms of both species. Certain selections have proved very resistant to some of the smut collections and rather susceptible to others. Some of them are so resistant to all collections tested that annual seed treatment for the prevention of smut would appear unnecessary. In case continued yield tests substantiate present indications, one or more of these new selections will merit extensive trial.

Breeding Winter Wheat for Resistance to Stinking Smut

(Tilletia levis and *Tilletia tritici)*

T. A. KIESSELBACH AND ARTHUR ANDERSON

Thru the use of control methods of selection and testing, a number of promising new lines of hard red winter wheat which are extremely resistant to the stinking smut or bunt disease caused by *Tilletia levis* Kühn and *Tilletia tritici* (Bjerk.) Wint. have been established at the Nebraska Agricultural Experiment Station. These investigations were undertaken because of the growing prevalence of this disease and the great financial loss caused thereby to wheat growers. Even tho effective means for its control thru seed treatment have been developed, the persistence of smut is apparent from the data in Table 1.

TABLE 1.—*Percentage of wheat grading smutty in terminal inspections of car load receipts at four Nebraska markets during seven years (1923-1929)*[1]

Terminal	1923	1924	1925	1926	1927	1298	1929
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Kearney	4.7	35.0	53.6	27.5	12.5	35.2	35.9
Lincoln	1.4	12.6	25.6	20.2	8.5	20.4	10.2
Omaha	14.2	26.1	39.8	39.8	21.4	27.7	28.4
Schuyler	17.5	26.5	19.5	20.9	12.2	11.7	13.9

[1]From U. S. D. A. reports 1-7, concerning smutty wheat — Nos. 1-6 by Boerner, Griffiths Leighty, and Meier; No. 7 by Boerner, Meier, and Haskell.

Statistics compiled by the U. S. Department of Agriculture indicate that 28 per cent of the cars of wheat received at Omaha during a seven-year period, 1923 to 1929, graded smutty. The price paid for such wheat is discounted because of its reduced milling value. This, together with the fact that the loss in grain yield has been found in unpublished Nebraska tests with local hard red winter varieties to be nearly proportional to the percentage of heads infected, stresses the advantages of a smut-resistant wheat.

In any attempt to produce new varieties that are resistant to smut, the importance of combining other desirable agronomic characteristics should not be overlooked. With this in view, the more resistant selections have also been tested in the field for yield and vegetative type and under controlled greenhouse conditions for reaction to low temperatures and black stem rust (*Puccinia graminis tritici* (Pers.) Erikss. and Henn.).

The use of control methods to insure disease epidemics and winterkilling is one of the newer aids in an effective winter wheat selection program. The opportunity for the determina-

tion of relative cold endurance may be long delayed when it is dependent entirely upon seasonal conditions in the field. This may be illustrated by the loss of 82 per cent of the entire Nebraska winter wheat acreage during the winter of 1916-1917 by winterkilling, whereas since that time stand losses due to cold have been relatively small.

Losses from occasional widespread stem-rust epidemics are well recognized. Such losses occurred in Nebraska in 1917, 1920, and 1923. Since the most productive varieties now commercially available in this region are more or less rust susceptible, the development of a productive wheat that is resistant to the prevailing physiologic forms of rust would seem highly desirable.

FOUNDATION VARIETIES

Improvement was undertaken by selection within commercial varieties and within hybrid populations. The tests by the former method have reached a somewhat more advanced stage.

Varieties for selection.—In planning a program of selection, it seemed desirable to begin with varieties whose general superiority had been established. Two such varieties of hard red winter wheat were available. These were Crimean (C. I. 1435) and Turkey (South Dakota No. 144). They had ranked second and fourth in yield, respectively, when compared with 42 other varieties and strains during an eight-year period, 1915 to 1922. (Kiesselbach, 1925.) This group of wheats included the best varieties obtainable from the experiment stations of the hard red winter wheat states and from the U. S. Department of Agriculture.

Varieties for hybridization. — The outstanding smut-resistant varieties available at the time these hybridization studies began were Regal, Sherman, Hussar, and Ridit. None of these had given evidence of being well adapted to this locality. They were crossed in 1924 with two standard local hard red winter varieties, Nebraska No. 6 and Kanred, which had proved very productive but susceptible to smut. A number of plant selections have been made from each of these hybrids, beginning in the third generation.

INITIAL SELECTION UNDER BUNT AND STEM-RUST EPIDEMIC CONDITIONS

A special planting was made in the fall of 1923 with seed of the Crimean (C. I. 1435) and Turkey (South Dakota No. 144) varieties which had been heavily inoculated with *T. levis* collected locally. The following spring an artificial epidemic of stem rust (*Puccinia graminis tritici*) was created in these

plats. Potted wheat plants heavily infected with 10 different physiologic forms of stem rust were distributed about the nursery in time to permit spread of the disease.[1] A water suspension containing spores of a number of physiologic forms of rust was also sprayed over the growing plants. Fairly severe epidemics of both rust and bunt developed. Four hundred and fifty-three heads were selected from smut-free and relatively rust-free plants in the case of the Crimean and 397 such selections were made from the Turkey variety, making a total of 850 selections. Fifty-one of these are still being grown because they have given some evidence of superior rust resistance.

ELIMINATION OF SELECTIONS SUSCEPTIBLE TO T. LEVIS COLLECTED LOCALLY (1925-1930)

After being inoculated with a local collection of *T. levis*, these 850 selections were planted in head rows in the fall of 1924. Thereafter plantings were made in 8- or 16-foot rows at normal rate. Except in cases of high resistance, where the entire row was carefully examined for bunt, the percentage of smut has been based on the number of smutted or partially smutted heads found in three to five lots of 100 consecutive heads.

TABLE 2.—*Relative distribution of 420 selections of winter wheat with reference to degree of infection when uniformly inoculated with* T. levis *collected locally (1926 and 1927)*

Variety and year	Percentage of infection									
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-100
(1)	*P. ct.* (2)	*P. ct.* (3)	*P. ct.* (4)	*P. ct.* (5)	*P. ct.* (6)	*P. ct.* (7)	*P. ct.* (8)	*P. ct.* (9)	*P. ct.* (10)	*P. ct.* (11)
	NUMBER OF STRAINS IN EACH GROUP									
Crimean (C. I. 1435)										
1926	0	2	3	33	48	56	42	25	8	1
1927	0	1	3	5	11	12	38	68	55	25
Turkey Red (So. Dak. 144)										
1926	32	26	33	29	35	23	18	5	1	0
1927	33	33	19	24	29	22	23	5	9	5

Weather conditions in 1925 were not favorable for severe epidemics of bunt. To illustrate, five relatively bunt-susceptible varieties which had been similarly inoculated averaged but 15 per cent infection. At harvest, only head rows

[1] This rust material was supplied by M. N. Levine of the Minnesota Agricultural Experiment Station and the potted plants used in the field were infected by G. L. Peltier, Station Plant Pathologist.

entirely free from smut were saved for continuation. Of the selections continued, 235 were from the Crimean and 222 from the Turkey.

Altho the infection averaged only 15 per cent for five susceptible varieties in 1925, it amounted to 47 and 49 per cent for the same varieties, respectively, in 1926 and 1927. The distribution of 218 selections of Crimean and 202 selections of Turkey with respect to their degree of infection is shown in Table 2 for 1926 and 1927. These results show very clearly that this particular importation of Turkey contains lines that are resistant to smut found locally. The Crimean, on the other hand, showed no such resistance. Because of these results, all the Crimean selections were dropped from the smut nursery and only 26 of the more promising Turkey selections were continued in 1928. Based on the 1928 results, only the 17 most smut-free lines were grown in 1929 and the number was reduced to 12 in 1930.

Results summarizing the comparative reactions of these 12 remaining selections and a number of standard varieties to the local collections of smut are shown in Table 3, for the period from 1924 to 1930. During the last four years, these 12 selections averaged 1.3 per cent infected heads, as compared with 33.3 per cent for the original Turkey and 40 per cent as an average for four standard productive varieties.

COMPARATIVE RESISTANCE TO COLLECTIONS OF SMUT FROM VARIOUS SOURCES

Several investigators, including Faris (1924), Rodenhiser and Stakman (1927), Gaines (1928), Reed (1928), and Roemer (1928), have reported concerning physiologic forms of bunt. Differential varietal response to these forms is now generally accepted. In view of the marked resistance of a number of these new Turkey selections to local collections of smut, it seemed desirable to determine their resistance to smut from various other sources in order that a number of physiologic forms might be represented.

Station workers in a number of states supplied the collections of smut used in these tests. Microscopic examination revealed that both species, namely *T. levis* and *T. tritici*, were represented. All collections from the central states, except one from Minnesota, were *T. levis*. All but one collection of *T. tritici* came from Pacific coast states. This is in agreement with the findings of Stephens and Woolman (1922), who report that in the United States *T. levis* is commonly found east of the Rocky Mountains while *T. tritici* is largely restricted to the more westerly states.

TABLE 3.—*Comparative resistance of varieties and selections of winter wheat to* T. levis *collected locally (1924-1930)*

Selection or variety	Percentage of infection						
	1924	1925	1926	1927	1928	1929	1930
(1)	*P. ct.* (2)	*P. ct.* (3)	*P. ct.* (4)	*P. ct.* (5)	*P. ct.* (6)	*P. ct.* (7)	*P. ct.* (8)
STANDARD VARIETIES							
Orig. So. Dak. No. 144	.....	10.0	51.0	37.0	37.0	34.0	25.0
Crimean (C. I. 1435)	.....	30.0	42.0	57.0	.....	.....	.....
Kanred	.....	21.0	48.0	53.0	41.0	39.0	27.0
Nebraska No. 60	.....	13.0	51.0	54.0	50.0	18.0	30.0
Nebraska No. 6	.....	3.0	45.0	43.0	76.0	37.0	30.0
NEBRASKA SELECTIONS FROM TURKEY RED (South Dakota No. 144)							
Selection No. 4300	0.0	0.0	4.0	6.0	0.2	1.7	4.5
Selection No. 4301	0.0	0.0	4.0	1.0	1.0	0.2	1.5
Selection No. 4303	0.0	0.0	.....	1.0	0.5	1.7	4.0
Selection No. 4304	0.0	0.0	2.0	1.0	0.3	0.6	0.4
Selection No. 4305	0.0	0.0	5.0	3.5	0.2	1.2	3.0
Selection No. 4311	0.0	0.0	0.0	2.5	0.0	1.0	3.5
Selection No. 4317	0.0	0.0	.....	2.0	0.1	0.0	2.0
Selection No. 4318	0.0	0.0	.....	0.0	0.4	0.2	0.5
Selection No. 4319	0.0	0.0	0.0	1.0	0.1	1.3	1.5
Selection No. 4322	0.0	0.0	4.0	2.5	0.5	0.6	0.5
Selection No. 4324	0.0	0.0	3.0	1.5	0.5	4.7	3.5
Selection No. 4325	0.0	0.0	3.0	0.5	0.1	1.5	1.0

Where data are lacking no tests were made or stands were not secured.

Methods.—Twenty-eight varieties or selections of winter wheat were uniformly inoculated with smut spores from 17 sources prior to planting in the fall of 1928 and with smut from 12 sources in the fall of 1929. The seed was given a standard formaldehyde treatment before inoculation, to guard against foreign infection. That such contamination was largely avoided was made evident by the fact that 22 of the 28 control rows were entirely free from bunt in 1929, while the infection in the other six rows ranged from only .2 to .8 per cent. In 1930, 24 of the control rows had no bunt while the other four contained from .5 to .7 per cent of infected heads.

Hands and utensils were thoroly cleansed whenever a change of smut collection was involved during the preparation, inoculation, and planting of the seed. Sufficient seed was weighed out in each case to plant an eight-foot row at normal rate. The seed and spores were carefully rubbed together so that each seed might carry sufficient spores. The 28 wheats treated with any one smut collection were planted in adjacent rows. The degree of infection was judged by the percentage of smutty heads. Two hundred heads were examined in each row except that where the infection was low all heads were carefully inspected.

Special care was used in guarding against the possible introduction and spread of new physiologic forms into this

locality. The seed was prepared for planting away from all other wheat and planted in an isolated nursery. After the head counts were made in the ensuing crop, the wheat was cut and burned in the field. As a further precaution against possible spread of some new virulent form, only those smuts secured from neighboring states between which a free seed exchange occurs have been grown in field cultures after the first year. Other collections are now being confined to the greenhouse.

The 28 wheats planted in the field included two standard susceptible and six established resistant varieties, the twelve new resistant Turkey selections reported in Table 3, and eight hybrid selections originating in the F_3 generation of crosses between susceptible and resistant sorts as previously described. The Minturki and Oro varieties have become available since the other four resistant sorts were used as parents for these eight hybrids. They were included because of their known resistance and other relatively desirable agronomic characters. In fact they are regarded as the best suited for this region of any of the established resistant varieties and for this reason are especially valuable for comparison.

Owing to the limited amount of space available, only 12 wheats were grown in the 1930 greenhouse tests for differential reactions. These included nine of the outstanding new Turkey selections and Nebraska No. 6, Minturki, and Oro. Fifteen planting samples containing fifty seeds each were prepared for each variety. These were inoculated individually with smut collections from 15 different sources and planted in 30-inch rows spaced 4½ inches apart. The method of preparing and planting the seed was the same in the greenhouse as has been described for the field tests. The percentage of infection is based on the total number of heads per row.

Results.—Tables 4, 5, and 6 show the detailed results of the reactions in the 1929 and 1930 field tests and the 1930 greenhouse tests. A relatively high degree of infection of the susceptible varieties resulted in all three tests. Several striking differential reactions were obtained among the varieties, selections, and hybrids. Some of the wheats proved extremely resistant to all of the collections. The degree of resistance, however, was somewhat variable.

In 1929, as an average for reactions to smut from 17 different sources, Nebraska No. 6 and Kanred averaged 27.9 per cent infected heads. Ridit and Minturki averaged most resistant of the resistant varieties, with .2 and 1.2 per cent of smut, respectively. Five of the Nebraska Turkey selections averaged less than 1 per cent of infection. Of the

TABLE 4.—*Comparative resistance of 28 varieties and selections of winter wheat to* T. levis *and* T. tritici *from 17 sources, 1929*

Varieties and selections	Species, source of collection,[1] and percentage of infection																
	Tilletia levis													*Tilletia tritici*			
	Lincoln, Nebr.	North Platte, Nebr	Mitchell, Nebr	Manhattan, Kans.	Fort Collins, Colo.	Brookings, S. Dak.	St Paul, Minn.[2]	St Paul, Minn.	La Fayette Ind.	Macleasn, Mont.	Corvallis, Oreg.	Pullman, Wash.[2]	Waterville, Wash.[3]	St. Paul, Minn.	Corvallis, Oreg.	Pendleton, Oreg.	Heppner, Oreg.[3]	Average
(1)	*P. ct.* (2)	*P. ct.* (3)	*P. ct.* (4)	*P. ct.* (5)	*P. ct.* (6)	*P. ct.* (7)	*P. ct.* (8)	*P. ct.* (9)	*P. ct.* (10)	*P. ct.* (11)	*P. ct.* (12)	*P. ct.* (13)	*P. ct.* (14)	*P. ct.* (15)	*P. ct.* (16)	*P. ct.* (17)	*P. ct.* (18)	*P. ct.* (19)
STANDARD SUSCEPTIBLE AND RESISTANT VARIETIES																		
Nebr. No. 6	37.0	49.0	30.0	36.0	40.0	31.0	17.0	27.0	6.0	52.0	17.0	30.0	28.0	17.0	23.0	17.0	65.0	30.7
Kanred	39.0	43.0	28.0	37.0	35.0	35.0	9.0	21.0	3.0	26.0	23.0	30.0	36.0	4.0	17.0	1.0	38.0	25.0
Minturki	2.7	2.9	1.3	0.8	0.8	1.3	1.6	2.1	0.2	0.8	0.2	0.4	0.4	0.2	1.4	0.2	2.9	1.2
Oro	1.9	1.3	0.8	0.4	0.6	0.8	0.4	1.3	0.0	19.0	0.0	0.2	1.2	0.0	0.0	0.0	0.8	1.7
Regal	0.6	0.0	0.4	0.6	0.2	0.2	2.1	22.7	5.2	2.6	2.5	17.4	1.6	3.8	10.3	0.0	30.3	5.9
Sherman	0.2	1.2	6.1	0.2	0.4	0.2	8.8	21.9	16.9	6.7	2.4	16.1	7.6	10.4	41.5	0.0	31.3	10.7
Hussar	0.0	0.4	1.6	0.0	0.0	0.2	0.0	15.2	0.4	3.4	2.4	8.2	0.2	1.3	0.0	0.0	8.6	2.5
Ridit	0.0	0.8	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.6	0.4	0.0	0.0	0.0	0.2	0.2
NEBRASKA SELECTIONS FROM TURKEY RED (South Dakota No. 144)																		
Selection No. 4300	1.7	2.4	5.3	0.4	1.9	0.9	4.1	2.4	0.7	10.9	0.8	1.1	1.6	1.3	1.2	0.2	1.3	2.2
Selection No. 4301	0.2	2.2	0.8	0.2	1.1	0.2	1.8	0.0	0.0	5.4	0.2	0.6	0.4	0.0	0.8	0.0	0.2	0.8
Selection No. 4303	1.7	1.2	1.7	0.4	1.1	0.8	0.8	0.6	1.3	6.3	0.0	0.4	0.4	0.6	1.2	0.0	1.2	1.2
Selection No. 4304	0.6	0.2	0.6	0.2	0.6	0.0	0.4	0.4	0.0	5.8	0.0	0.2	0.0	0.2	0.0	0.0	1.2	0.6
Selection No. 4305	1.2	0.6	1.8	1.3	0.8	0.0	1.6	1.0	1.8	7.4	0.2	0.4	0.4	0.4	0.0	0.0	1.4	1.2
Selection No. 4311	1.0	0.2	6.0	0.0	0.6	0.0	12.9	36.8	20.7	5.6	3.7	8.5	21.0	32.0	23.7	0.0	30.9	12.4
Selection No. 4317	0.0	0.2	0.4	0.0	0.6	0.0	0.8	0.4	0.0	13.5	0.4	0.0	0.4	0.0	0.0	0.0	0.0	1.0
Selection No. 4318	0.2	0.2	0.2	0.0	0.0	0.0	0.6	0.0	0.0	6.2	0.0	0.6	0.8	0.2	0.0	0.0	0.2	0.5
Selection No. 4319	1.3	0.2	0.8	0.0	0.0	0.4	0.2	0.0	0.8	5.7	0.0	0.0	1.2	0.2	0.0	0.0	0.9	0.7
Selection No. 4322	0.6	2.5	2.4	0.4	1.2	0.0	8.2	18.0	7.8	3.2	3.9	11.6	12.9	9.7	14.1	0.0	21.0	6.9
Selection No. 4324	4.7	7.0	2.5	1.4	4.2	1.1	9.9	2.4	4.1	8.9	0.0	0.8	12.0	7.8	4.4	0.0	3.2	4.4
Selection No. 4325	1.5	0.2	0.4	0.0	0.0	0.8	0.4	0.2	0.2	7.9	0.2	0.0	0.6	0.0	0.0	0.0	0.0	0.7
NEBRASKA HYBRID SELECTIONS																		
Sherman x Nebr. No. 6	0.0	0.0	0.6	0.0	0.2	0.0	5.5	10.9	9.7	3.3	5.7	14.0	21.7	4.8	7.3	0.0	15.2	5.8
Hussar x Nebr. No. 6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	8.7	2.5	4.0	13.3	10.8	11.4	1.2	0.0	0.0	20.9	4.3
Hussar x Kanred	0.4	0.0	0.4	0.0	0.0	0.0	0.2	19.5	0.6	6.3	10.2	11.9	5.6	0.4	0.4	0.0	34.1	5.3
Kanred x Ridit	2.1	2.3	1.1	0.0	0.8	0.4	0.0	0.4	0.8	1.1	0.2	2.1	0.4	0.0	0.4	0.2	2.4	0.9
Nebr. No. 6 x Ridit	2.3	3.1	1.8	5.6	2.5	2.1	1.2	2.3	2.8	1.5	4.3	0.4	3.5	0.4	2.2	0.4	3.0	2.3
Nebr. No. 6 x Regal	0.0	0.0	0.0	0.0	0.0	0.2	0.2	5.6	0.2	2.0	14.7	10.2	4.9	0.6	0.0	0.0	30.6	4.1
Kanred x Regal	0.0	0.0	0.2	0.2	0.0	0.6	0.0	8.1	1.8	4.0	9.3	13.9	8.0	0.4	1.4	0.0	31.7	4.7
Sherman x Kanred	0.8	0.4	4.9	0.8	0.0	0.8	13.9	27.3	41.6	9.1	24.8	20.1	10.7	18.6	29.8	1.2	43.7	14.6

[1]The collections listed in Columns 2 to 8 were secured directly from the Agr. Exp. Stations at the points indicated; those in Columns 9 to 18 were obtained from E. N. Bressman of the Oreg. Agr. Exp. Sta., who previously had secured them from the designated locations.

[2]These St. Paul, Waterville, and Pullman collections contained 10 and 5 per cent and trace of *T. tritici*, respectively.

[3]Contained 20 per cent of *T. levis*.

TABLE 5.—*Comparative resistance of 28 varieties of winter wheat to* T. levis *from 12 sources, 1930*

Varieties and selections	Source of collection[1] and percentage of infection												
	Nebraska				Kans.	Colorado		S. D.	N. D.	Minn.	Montana		Average
	Lincoln	Lincoln	North Platte	Mitchell	Manhattan	Fort Collins[2]	Akron	Brookings	Fargo	St. Paul[3]	Moccasin[3]	Bozeman	
(1)	*P. ct.* (2)	*P. ct.* (3)	*P. ct.* (4)	*P. ct.* (5)	*P. ct.* (6)	*P. ct.* (7)	*P. ct.* (8)	*P. ct.* (9)	*P. ct.* (10)	*P. ct.* (11)	*P. ct.* (12)	*P. ct.* (13)	*P. ct.* (14)
STANDARD SUSCEPTIBLE AND RESISTANT VARIETIES													
Nebraska No. 6	27.5	25.0	36.0	23.5	40.5	.....	13.8	29.5	25.7	6.3	30.5	36.5	26.8
Kanred	22.5	9.5	29.5	23.5	33.5	.....	28.0	21.5	12.5	6.5	30.5	22.0	21.8
Minturki	0.0	0.5	2.0	3.0	1.0	.....	3.5	4.0	3.0	2.2	1.0	0.5	1.9
Oro	0.0	0.0	0.5	0.0	1.5	.....	0.0	1.0	1.5	0.0	1.8	1.0	0.7
Regal	0.5	0.0	1.5	2.0	0.5	.....	2.9	3.5	0.7	0.7	9.8	0.0	2.0
Sherman	5.5	5.0	5.0	5.5	5.3	.....	10.6	8.0	3.0	7.6	9.3	11.7	7.0
Hussar	2.9	0.9	2.1	0.0	3.4	.....	1.3	6.5	0.0	0.0	7.1	0.9	2.3
Ridit	5.3	1.3	7.3	0.5	1.9	.....	0.5	4.0	0.0	0.0	2.4	0.6	2.2
NEBRASKA SELECTIONS FROM TURKEY RED (South Dakota No. 144)													
Selection No. 4300	0.0	0.0	0.5	0.0	2.0	.....	2.0	1.5	1.5	1.0	0.5	1.5	1.0
Selection No. 4301	0.0	0.0	1.5	0.5	0.6	.....	1.8	0.1	1.0	0.6	2.5	0.0	0.8
Selection No. 4303	2.2	2.9	1.0	0.5	3.5	.....	4.6	1.0	1.0	1.1	5.7	0.5	2.2
Selection No. 4304	0.0	0.0	0.5	0.1	0.0	.....	1.5	0.0	1.0	0.0	0.0	0.0	0.3
Selection No. 4305	1.0	1.5	0.5	0.0	4.0	.....	1.0	0.0	1.5	0.5	3.5	0.0	1.2
Selection No. 4311	0.0	0.0	0.0	0.0	1.0	.....	0.5	0.5	0.0	1.8	6.5	0.5	1.0
Selection No. 4317	3.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	1.0	0.0	1.5	0.5	0.6
Selection No. 4318	0.5	0.0	0.5	0.0	0.0	0.0	1.0	2.0	0.5	0.0	2.0	0.0	0.6
Selection No. 4319	0.5	0.0	0.0	0.0	1.0	0.5	0.5	0.0	0.5	0.0	0.5	0.0	0.3
Selection No. 4322	0.0	0.0	0.0	1.0	1.0	0.5	3.2	0.0	1.1	9.0	9.4	0.6	2.3
Selection No. 4324	3.1	3.8	1.5	1.5	1.6	4.0	1.0	2.8	2.8	1.2	1.9	0.0	1.9
Selection No. 4325	0.5	0.0	1.0	0.0	0.5	0.0	1.5	1.0	0.0	1.5	0.0	0.0	0.5
NEBRASKA HYBRID SELECTIONS													
Sherman x Nebr. No. 6	1.1	2.3	0.0	0.5	0.0	0.0	3.7	0.7	1.0	6.8	11.3	2.9	2.8
Hussar x Nebr. No. 6	0.0	0.0	0.0	1.5	1.0	0.0	3.9	0.5	0.0	1.8	6.0	0.0	1.3
Hussar x Kanred	0.0	0.0	0.5	1.0	0.6	0.0	4.7	2.1	0.0	1.9	9.0	3.1	2.1
Kanred x Ridit	5.5	0.0	2.5	2.0	6.0	3.5	2.5	5.4	0.0	0.0	2.0	1.0	2.5
Nebr. No. 6 x Ridit	6.1	3.3	2.5	4.0	8.5	0.5	1.2	1.8	0.0	4.1	2.4	1.7	3.2
Nebr. No. 6 x Regal	1.0	0.0	0.0	0.5	0.0	0.0	1.5	0.0	0.0	2.1	19.5	0.5	2.3
Kanred x Regal	0.5	0.7	0.0	0.0	0.0	0.0	2.1	1.2	0.7	3.8	17.0	0.0	2.4
Sherman x Kanred	0.0	4.4	1.2	0.5	0.0	0.5	3.0	0.6	0.0	21.1	5.5	0.0	3.3

[1]All of the smut collections were taken from the 1929 differential nursery at Lincoln except those reported in Columns 2 and 10. Those listed in Columns 8 12 and 13, were originally supplied by the Office of Cereal Crops and Diseases, U. S. D. A.

[2]First 14 rows were not inoculated with smut from Fort Collins due to insufficient supply. This collection is omitted from averages.

[3]The smut from St. Paul and Moccasin contained 25 and 5 per cent of *T. tritici*, respectively.

TABLE 6.—*Comparative resistance of 12 varieties and selections of winter wheat to* T. levis *and* T. tritici *from 15 sources. Greenhouse, 1930*

Varieties and selections	Species, source of collection[1] and percentage of infection															
	Tilletia levis									*Tilletia tritici*						
	Lincoln, Nebr.	St. Paul, Minn.	LaFayette, Ind.	Moccasin, Mont.[2]	Idaho	Corvallis, Oreg.[2]	Pullman, Wash.[2]	Waterville, Wash.[2]	Czechoslovakia	St. Paul, Minn.	Creigmont, Idaho	Corvallis, Oreg.	Pendleton, Oreg.[2]	Redmond, Oreg.	Heppner, Oreg.[2]	Average
(1)	*P. ct.* (2)	*P. ct.* (3)	*P. ct.* (4)	*P. ct.* (5)	*P. ct.* (6)	*P. ct.* (7)	*P. ct.* (8)	*P. ct.* (9)	*P. ct.* (10)	*P. ct.* (11)	*P. ct.* (12)	*P. ct.* (13)	*P. ct.* (14)	*P. ct.* (15)	*P. ct.* (16)	*P. ct.* (17)
Nebraska No. 6	48.1	4.0	52.4	90.0	30.0	55.6	20.0	83.7	27.3	23.0	14.8	25.0	53.8	45.0	53.8	41.7
Minturki	3.4	0.0	0.0	22.0	3.7	5.5	0.0	0.0	2.7	0.0	4.2	0.0	0.0	0.0	0.0	2.6
Oro	5.4	0.0	8.9	45.6	8.3	4.7	12.3	3.9	0.0	1.7	0.0	0.0	0.0	0.0	2.2	5.8
Selection No. 4300	1.7	0.0	6.6	8.9	6.3	1.9	0.0	0.0	5.5	6.3	7.3	3.1	3.4	0.0	2.0	3.3
Selection No. 4301	3.6	0.0	2.0	4.4	0.0	1.7	2.5	4.5	0.0	2.3	0.0	0.0	0.0	0.0	0.0	1.3
Selection No. 4303	4.7	0.0	3.0	23.7	0.0	6.3	0.0	6.7	6.4	21.7	7.7	3.3	7.3	0.0	2.4	5.8
Selection No. 4304	0.0	0.0	1.8	25.0	0.0	3.7	0.0	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2
Selection No. 4305	2.6	0.0	15.6	7.5	0.0	4.9	9.0	1.6	0.0	5.3	0.0	0.0	1.8	1.8	3.5	3.4
Selection No. 4317	0.0	0.0	0.0	23.2	0.0	0.0	2.0	0.0	0.0	4.5	0.0	0.0	0.0	4.8	8.5	2.7
Selection No. 4318	0.0	0.0	1.9	21.7	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	1.7
Selection No. 4319	0.0	0.0	0.0	6.1	0.0	0.0	1.5	0.0	0.0	3.8	1.6	0.0	0.0	1.4	0.0	0.9
Selection No. 4325	1.5	0.0	0.0	2.1	2.4	0.0	0.0	1.5	4.0	0.0	2.0	1.3	0.0	0.0	9.2	1.5

[1]These collections of smut were supplied by E. N. Bressman of the Oregon Agr. Exp. Sta., who had previously secured them from the designated sources.

[2]Contained traces of *T. tritici* or *T. levis*.

hybrids, a selection from Kanred by Ridit was the most resistant with only .9 per cent smutty heads.

In 1930, in the field (Table 5), Nebraska No. 6 and Kanred averaged 24.3 per cent smutty heads. Of the resistant varieties, Oro and Minturki contained the lowest amount of smut, with .7 and 1.9 per cent respectively. Six of the new Turkey selections averaged less than 1 per cent bunt. The Kanred by Ridit selection averaged 2.5 per cent infection, as compared with 1.3 per cent for the most resistant hybrid selection, Hussar by Nebraska No. 6.

The fifteen collections of smut used in the 1930 greenhouse test were supplied by E. N. Bressman of the Oregon Agricultural Experiment Station, who had selected them from among 78 different lots of bunt because of their wide range of specific differential reactions on a number of varieties of wheat. These included the various physiologic forms reported by Bressman (1931).

In reaction to all of these collections, the susceptible variety, Nebraska No. 6, averaged 41.7 per cent smutty heads. Minturki and Oro showed averages of 2.6 and 5.8 per cent of infection, respectively. Four of the Turkey selections averaged less than 2 per cent smutty heads.

NEBRASKA RESULTS FROM THE U. S. DEPARTMENT OF AGRICULTURE UNIFORM BUNT NURSERY

In addition to the field tests with bunt, rather similar tests were conducted in 1929 and 1930 in co-operation with the Office of Cereal Crops and Diseases, U. S. Department of Agriculture. The results are here presented because in addition to the regular varieties included in the U. S. Department of Agriculture uniform bunt nursery at the Nebraska Agricultural Experiment Station, one of the new Nebraska Turkey selections, No. 4319, was similarly inoculated in 1929, and nine of the Turkey selections were similarly treated in 1930. The results are given in Tables 7 and 8.

This U. S. Department of Agriculture collection of wheats included three recognized resistant varieties and seven susceptible sorts. All were inoculated individually with smut from each of nine sources. It is of interest to note that the Nebraska Turkey selection No. 4319 averaged only .1 per cent of infection, as compared with 1.9 per cent for Minturki and 1.5 per cent for Oro in 1929.

In 1930, this same Turkey selection No. 4319 averaged .1 per cent infection for the nine collections of smut compared with 2.5 per cent for Minturki and 1.2 per cent for Oro. The nine Turkey selections averaged .4 per cent smutty heads in contrast with 25 per cent for the average of seven susceptible varieties.

TABLE 7.—*Comparative resistance of 11 varieties of winter wheat to* T. levis *from nine sources. Conducted in co-operation with the Office of Cereal Crops and Diseases, U. S. D. A., 1929*

Variety	Source of collection and percentage of infection									
	Lincoln, Nebr.	North Platte, Nebr.	Manhattan, Kans.	Hays, Kans.	Akron, Colo.	Redfield, S. D.	St. Paul, Minn.	Moccasin, Mont.[1]	Bozeman, Mont.[1]	Average
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Kharkof	26.2	28.8	14.5	7.3	27.5	4.8	6.2	21.9	29.0	18.5
Karmont	24.2	29.7	28.3	5.2	26.9	7.8	18.7	24.8	33.0	22.1
Newturk	22.5	32.1	15.2	5.7	23.4	2.6	10.0	19.9	22.8	17.1
Kanred	33.2	28.5	13.8	6.3	13.4	1.4	15.5	29.1	35.4	19.6
Blackhull	33.9	23.7	20.0	9.5	30.6	5.2	33.3	29.0	30.3	23.9
Tenmarq	24.7	31.3	17.0	8.9	27.2	2.7	5.1	27.7	23.8	18.7
Nebraska No. 60	18.4	19.8	3.1	5.7	25.9	2.5	17.2	18.6	19.3	14.5
Mint. x Bel.-Buf	0.7	2.1	1.0	0.0	3.5	0.2	1.4	1.3	2.7	1.4
Oro	1.3	3.7	0.7	0.0	2.8	0.3	0.0	1.3	3.4	1.5
Minturki	0.6	3.4	0.3	0.6	1.9	1.9	3.3	2.8	2.7	1.9
Nebr. Sel. No. 4319	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

[1] Contained a trace of *T. tritici*.

TABLE 8.—*Comparative resistance of 19 varieties of winter wheat to* T. levis *from nine sources. Conducted in co-operation with the Office of Cereal Crops and Diseases, U. S. D. A., 1930*

Variety	Source of collection and percentage of infection									
	Lincoln, Nebr.	North Platte, Nebr.	Manhattan, Kans.	Hays, Kans.	Akron, Colo.	Redfield, S. D.	St. Paul, Minn.[1]	Moccasin, Mont.[1]	Bozeman, Mont.	Average
(1)	*P. ct.* (2)	*P. ct.* (3)	*P. ct.* (4)	*P. ct.* (5)	*P. ct.* (6)	*P. ct.* (7)	*P. ct.* (8)	*P. ct.* (9)	*P. ct.* (10)	*P. ct.* (11)
Kharkof	38.8	29.3	13.6	27.0	44.3	10.3	6.6	22.9	21.1	23.8
Karmont	38.5	27.3	14.6	31.3	33.1	17.4	11.4	45.0	20.6	26.6
Newturk	22.0	15.1	28.2	29.2	28.5	24.1	19.6	35.1	30.0	25.8
Kanred	36.3	18.2	7.2	26.6	58.1	5.6	9.1	27.0	36.9	25.0
Blackhull	46.1	26.7	31.8	52.2	60.3	21.6	28.7	32.0	31.1	36.7
Tenmarq	27.0	22.7	8.3	10.8	32.1	11.3	8.0	19.6	21.3	17.9
Nebraska No. 60	40.3	6.5	10.3	29.5	13.9	8.4	17.8	10.8	33.1	19.0
Mint. x Bel.-Buf	0.7	1.7	0.0	2.2	0.0	0.5	0.7	1.5	0.5	0.9
Oro	0.0	2.8	0.0	2.5	0.0	1.3	0.7	3.0	0.7	1.2
Minturki	5.9	1.8	0.6	5.1	3.1	1.9	2.0	0.0	2.5	2.5
Nebr. Sel. No. 4300	0.0	0.0	0.8	3.4	0.0	0.0	0.0	0.0	0.6	0.5
Nebr. Sel. No. 4301	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nebr. Sel. No. 4303	0.0	4.0	0.0	0.0	0.0	0.8	5.9	0.0	0.9	1.3
Nebr. Sel. No. 4304	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nebr. Sel. No. 4305	0.0	0.0	0.0	1.4	1.3	0.0	0.0	4.8	0.0	0.8
Nebr. Sel. No. 4317	0.0	1.4	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.4
Nebr. Sel. No. 4318	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.2
Nebr. Sel. No. 4319	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.1
Nebr. Sel. No. 4325	0.0	2.3	0.0	0.0	0.9	0.0	0.0	0.6	1.0	0.5

[1]Contained a trace of *T. tritici*.

In conjunction with the two U. S. Department of Agriculture uniform bunt tests, the Nebraska Turkey selection No. 4319 was entirely unaffected by smut from six different sources during both years. It was entirely smut-free in 41 of the 69 instances reported in the preceding tables and averaged but 1.3 per cent infection in the 28 remaining cases. Maximum infection was 6 per cent as compared with 90 per cent for Nebraska No. 6.

SUPPLEMENTARY TEST FOR RESISTANCE TO STEM RUST

The nine smut-resistant selections from Turkey (South Dakota No. 144) (Table 8 and preceding tables), together with Kanred and Nebraska Crimean Nos. 12 and 50, were tested in the seedling stage in the greenhouse for resistance to stem rust during the winter of 1929-1930 by Geo. L. Peltier, Station Plant Pathologist. The reactions of these wheats to the four physiologic forms of stem rust found by him to be prevalent in Nebraska in 1929 were determined in duplicate tests. As shown in Table 9, all of the Turkey selections have given evidence of being relatively resistant to all four forms, whereas the Kanred and Crimean selections were susceptible to them.

TABLE 9.—*Comparative reactions* [1] *of 12 strains and varieties of winter wheat to four physiologic forms of* Puccinia graminis tritici [2]

Variety or selection	Physiologic forms			
	18	34	39	56
(1)	(2)	(3)	(4)	(5)
Kanred	S	S	S	S
Crimean No. 12	S	S	S	S
Crimean No. 50	S	S	S	S
Selection No. 4300	S–	S–	R	S–
Selection No. 4301	S–	S–	S–	S–
Selection No. 4303	S–	S–	R	S–
Selection No. 4304	S–	S–	S–	S–
Selection No. 4305	S–	S–	R	S–
Selection No. 4317	S–	S–	S–	S–
Selection No. 4318	S–	S–	S–	S–
Selection No. 4319	S–	S–	R	S–
Selection No. 4325	S–	S–	R	S–

[1] Explanation of symbols: S, susceptible; S–, slightly susceptible; R, resistant.

[2] Acknowledgment is made to G. L. Peltier, Station Plant Pathologist, for the determination of these reactions.

COMPARATIVE COLD RESISTANCE

In view of the work of Steinmetz (1926), Hill and Salmon (1927), Akerman (1927), and investigations in progress with alfalfa at this station by Peltier and Tysdal, it seemed desir-

able to compare a number of the promising selections with respect to cold resistance under controlled conditions. The freezing equipment installed in 1927 in the greenhouse was made available thru the courtesy of the Department of Plant Pathology for such studies.

Planting.—The wheat to be compared was planted on October 17, 1929, in soil-filled boxes 5 x 17 x 19 inches. These boxes were placed contiguously in a shallow excavation in the wheat field with their tops level with the soil surface. They remained in the field until removed to the freezing chamber. The wheat, therefore, was subjected to such hardening-off as occurred naturally in the field.

FIG. 1.—Manner of growing winter wheat varieties in flats for controlled cold-endurance tests. Right: Wheat removed from field to greenhouse January 31 and photographed February 22, without additional freezing. Left: Corresponding wheat 20 days after being subjected for 30 hours in the freezing chamber to a minimum air temperature of −30° C. and minimum soil temperature of −29° C.

The seeds were spaced at approximately one-half inch intervals in rows 2½ inches apart. Seven rows were planted in each box. The first, fourth, and seventh rows were planted as checks to Blackhull, Nebraska No. 60, and Minturki, respectively. These three varieties were known to differ in relative winterhardiness. Twelve strains, including nine new Turkey selections which had proved resistant to bunt, two new high-yielding Nebraska Crimean (C. I. 1435) selections, and Oro, were planted in rows 2, 3, 5, and 6 for comparative testing. Three boxes were thus required for a complete set. In addition, a number of control boxes for determining proper exposures and technique were planted to

two rows each of Blackhull, Nebraska No. 60, and Minturki and one row of Crimean No. 50, a Nebraska selection from Crimean C. I. 1435.

A field count of the plants on November 12 indicated good and comparatively uniform stands in all of the boxes, with a relatively small amount of growth due to delayed planting. The soil in the boxes was kept well watered until it became frozen in November. Following a thawing out of the soil in late December, it was again watered.

Hardening-off temperatures in the field.—The mean outdoor temperature for November was 2.6° C. below normal, the minimum of –18.3° C. occurring on the 22nd. The mean temperature for December was .8° C. above normal with a minimum of –19.4° C. on December 18. The last week averaged 9.4° C. above normal. The January mean, on the other hand, was 4.9° C. below normal. The minimum temperature of –26.7° C. occurred on January 17 with a range in minimum temperature from –18.3° C. to –26.7° C. from January 14 to January 23.

Temperatures maintained in freezing chamber.—One or two complete sets of the wheat varieties under test were frozen by control methods on eight different dates between December 2 and January 31. The average results from 12 comparisons are reported in Table 10. Soil temperatures as measured by thermocouples imbedded approximately three-fourths inch deep in the individual boxes ranged in the various tests from –.5° C. to –16.3° C. at the beginning of the freezing and from –21.3° C. to –29.1° C. at the time the boxes were removed from the freezing chamber. With the exception of one eight-hour period, the boxes were retained in the freezing chamber from 30 to 35 hours. An average air temperature of –25.5° C. was maintained in the freezing chamber, with an average minimum of –30.7° C. The duration of freezing was gauged by the minimum soil temperature.

Comparative recovery from freezing.—Upon removal of boxes from the freezing chamber, they were placed on a table in the greenhouse for recovery under favorable growth conditions with a mean temperature of about 22° C. Final readings of the percentage of survival were made at the end of approximately four weeks. This length of time was regarded as necessary, since some plants gave early evidence of recovery but later succumbed as a result of the freezing.

In Table 10, Columns 4, 5, and 6, are recorded the percentages of survival for each of the three check varieties grown in conjunction with each of the selections listed in Column 1. In Column 7 is recorded the survival for each of the selections listed in Column 1. The ratio of this survival

TABLE 10.—*The survival of new winter wheat selections in comparison with that of three standard varieties of known relative hardiness after being exposed to low temperatures under controlled conditions* [1]

Selection	Range in soil temperature centigrade		Percentage of survival					Odds compared with Nebr. No. 60 (student's method)
			Standard varieties			Selection (Col. 1)	Ratio to Nebr. No. 60	
	Max.	Min.	Blackhull	Nebr. No. 60	Minturki			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Selection No. 4300	–9.6	–26.3	36	68	76	70	1.03	3
Selection No. 4301	–9.0	–26.4	33	67	76	52	0.78	109
Selection No. 4303	–9.5	–26.5	30	68	79	48	0.71	1444
Selection No. 4304	–9.7	–26.4	30	69	79	51	0.74	4999
Selection No. 4305	–9.7	–26.5	33	63	73	51	0.81	40
Selection No. 4317	–9.5	–26.4	38	72	78	63	0.88	16
Selection No. 4318	–9.3	–26.4	36	70	79	58	0.83	104
Selection No. 4319	–9.3	–26.3	34	66	76	64	0.97	4
Selection No. 4325	–9.4	–26.5	28	64	76	60	0.94	3
Crimean No. 12	–9.7	–26.4	34	68	74	67	0.99	1
Crimean No. 50	–9.7	–26.4	34	68	74	72	1.06	9
Oro	–9.4	–26.5	29	67	76	59	0.88	40

[1] Average of 12 comparisons, frozen on eight different dates from Dec. 2. to Jan. 31. Average duration of freezing period 30 hours, mean average and minimum air temperatures in freezing room —25.5 and —30.7° C, respectively.

TABLE 11.—*Comparative cold survival of three varieties of winter wheat under controlled freezing conditions and in the U. S. D. A. uniform winterhardiness tests*

Variety	Kind of Test		
	Controlled freezing 1930	U. S. D. A. winterhardiness nursery—average for 9 to 23 stations per year	
		1930[1]	Nine-year average, 1921-1929[2]
(1)	*P. ct.* (2)	*P. ct.* (3)	*P. ct.* (4)
Minturki	76	68	65
Nebraska No. 60	68	61	59
Blackhull	33	46	42

[1]The unpublished 1930 U. S. D. A. data were supplied by J. A. Clark and K. S. Quisenberry.
[2]From U. S. D. A. Circular No. 141.

to that of Nebraska No. 60, grown and frozen comparably in the same box, is shown for each selection in Column 8.

It may be concluded from these results that the Turkey selections Nos. 4300, 4319, and 4325, and Crimean selections Nos. 12 and 50 are as winterhardy as Nebraska No. 60. There is satisfaction in knowing this, since Nebraska No. 60 is recognized as a comparatively hardy variety for Nebraska conditions.

Dependability of controlled freezing tests.—It is of interest to know how the foregoing controlled freezing results compare with those secured under actual field conditions of winterkilling. The three varieties used as controls exhibited rather similar degrees of hardiness and ranked the same as under field conditions in the U. S. Department of Agriculture uniform winterhardiness nursery during a nine-year period, 1921 to 1929. (Quisenberry and Clark, 1930.) In this government field-survival test, in which northern states and Canada were represented, the mean survivals for Blackhull, Nebraska No. 60, and Minturki were 42, 59, and 65 per cent, respectively, as compared with averages of 33, 68, and 76 per cent for these controlled comparisons. (See Table 11.) This similarity of survival is evidence of the reliability of this controlled procedure.

TABLE 12.—*Comparative yields, bunt resistance, rust resistance, cold resistance, and other agronomic characters of nine new Turkey selections and three standard varieties of winter wheat, 1930* [1]

Variety or selection	Yield of grain per acre		Percentage bunt-infected heads in crop from inoculated seed				Cold survival			Stem rust reactions[2]	Miscellaneous notes		
								Greenhouse					
	Field plats—(duplicate)	Nursery (10 replications)	Local bunt	Av. of 9 U.S.D.A. bunts	Av. of 15 bunts in greenhouse	Av. of 12 bunts in field test	Field	Relative to Nebr. No. 60	Odds		Test weight per bushel	Date in head	Date ripe
(1)	*Bushels* (2)	*Bushels* (3)	*P. ct.* (4)	*P. ct.* (5)	*P. ct.* (6)	*P. ct.* (7)	*P. ct.* (8)	*P. ct.* (9)	(10)	(11)	*Lbs.* (12)	(13)	(14)
Nebr. No. 60	38.5	.....	30.0	19.1	41.7[3]	26.8[3]	100	100	.....	S	63.1	5/29	6/30
Kanred	39.4	.....	27.0	25.0	.....	21.8	100	.....	.....	S	62.7	5/28	6/29
S. Dak. No. 144	42.4	25.7	25.0	.....	.....	.....	100	.....	.....	S	64.0	5/27	6/29
Sel. No. 4300	43.1	23.8	4.5	0.5	3.3	1.0	100	103	3	S–	64.0	5/27	6/29
Sel. No. 4301	44.5	24.2	1.5	0.0	1.3	0.8	100	78	109	S–	63.5	5/28	6/29
Sel. No. 4303	44.0	23.8	4.0	1.3	5.8	2.2	100	71	1444	S–	63.0	5/27	6/29
Sel. No. 4304	44.6	24.8	0.4	0.0	2.2	0.3	100	74	4999	S–	63.0	5/28	6/29
Sel. No. 4305	42.6	24.6	3.0	0.8	3.4	1.2	100	81	40	S–	63.5	5/26	6/28
Sel. No. 4317	41.6	23.6	2.0	0.4	2.7	0.6	100	88	16	S–	62.8	5/27	6/29
Sel. No. 4318	42.5	24.1	0.5	0.2	1.7	0.6	100	83	104	S–	63.2	5/27	6/28
Sel. No. 4319	42.8	26.6	1.5	0.1	0.9	0.3	100	97	4	S–	63.3	5/26	6/27
Sel. No. 4325	43.3	25.8	1.0	0.5	1.5	0.5	100	94	3	S–	63.3	5/26	6/27

[1]This table summarizes the cold and disease reactions for these selections that are reported in previous tables and includes additional yield and other field data.

[2]Average reactions in seedling stage to four physiologic forms, Nos. 18, 34, 39, and 56. S=susceptible and S–=slightly susceptible.

[3]These two bunt percentages are for Nebr. No. 6 wheat, which resembles Nebr. No. 60 in susceptibility.

COMPARATIVE YIELDS OF NEW SMUT-RESISTANT SELECTIONS

Prior to 1930, the investigations with the new selections made from South Dakota Turkey No. 144 were concerned primarily with the development of bunt-resistant lines. All discarding following the first selection was on the basis of reaction to bunt. After nine selections with a very favorable smut-resistance record during a period of years had been isolated, it became desirable to learn their general comparative value with respect to other agronomic characters. These complete data for 1930 are assembled in Table 12 in comparison with the three standard varieties—Nebraska No. 60, Kanred, and the parent Turkey variety, South Dakota No. 144. In duplicate one-thirtieth-acre plats, all of these selections yielded two or more bushels per acre above Nebraska No. 60 and Kanred, which are now regarded as the two most productive varieties grown extensively in this state. In the nursery, the nine selections ranged from 1.9 bushels below that of the parent variety to .9 bushel above.

A straight average of two smut inoculation tests shows 1.2 per cent infection for the nine new Turkey selections, as compared with an average of 25.3 per cent for Kanred and Nebraska No. 60. In a similar comparison with Nebraska No. 60 in four independent tests representing a rather large number of smut collections, these nine Turkey selections averaged 1.4 per cent smut in contrast with 29.4 per cent for the Nebraska No. 60. Altho the nine do not average as winter-hardy as Nebraska No. 60, three of them, Nos. 4300, 4319, and 4325, give evidence of being about as hardy. The No. 4319 ripened three days earlier and was somewhat shorter strawed than Nebraska No. 60. In a test with smut-free seed this strain averaged 4.3 bushels higher in yield than Nebraska No. 60. It also developed only .9 per cent bunt, as compared with 29.4 per cent for No. 60 in the four tests when artificially inoculated with smut from a number of sources. Its lodge and shattering resistance and other qualities appeared satisfactory.

It would seem from the data available that a number of these Turkey selections give distinct promise of favorable production and should prove attractive as parents in a breeding program.

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